

## THE PETRIFICATION OF FOSSIL BONES.

BY E. GOLDSMITH.

The Port Kennedy limestone quarry, situated on the Schuylkill River, in Montgomery Co., Pa., became noted some twenty-five years ago for a deposit of fossil bones which were studied, in part, by Professors Joseph Leidy and Edw. D. Cope. Recently a fresh interest in the subject was awakened, and Mr. Mercer, the well-known archæologist, superintended some further diggings, especially in the hope of finding human remains in the fissure, the receptacle of the fossils, in the Silurian limestone.

Mr. Mercer's statement that a considerable part of those fossil bones crumbled, or, as he expressed it, "fell to a mealy powder" when touched, attracted my attention. In order to ascertain into what form and composition the bone-phosphate had been changed, I visited the locality and saw the peculiar position of the fissure filled with the moist débris derived from the overlying Mesozoic red sandstone. The mealy matter above referred to was easily found because there was more of it than solid fossil bones; although it is astonishing how many fragments of bones were in view, a sight delightful to the paleontologist.

I selected for my investigation a curved bone, apparently a transverse section of a scapula of perhaps one of the larger cats, about  $\frac{5}{8}$  of an inch thick in the middle and tapering toward both ends. Clean material could easily be dug out with a knife. On drying the sample it appears as a yellowish, fine sand of even grain: Mr. Mercer's fossil bone meal. This fine grained mealy material was certainly at one time, a portion of a bone; but its composition is no longer calcium phosphate, a chemical analysis proving that phosphoric acid was almost or entirely absent. The reaction for phosphoric acid with the ammonium molybdate solution was very slight, there seemed to be but a small fraction of one per cent. of the calcium phosphate left in the specimen. It was further ascertained that this so-called bone-meal is now essentially calcium carbonate containing some magnesia. Is this material really amorphous as it appears under ordinary conditions? A slide, prepared in the ordi-

nary way with balsam indicated beneath the microscope that nearly every particle had crystallized into a mineral. Groups of three or six crystals were recognized with a low power objective. In polarized light some of the crystals showed extinction parallel to the longer axis.

A pile of rubbish, which had been dug out of the bone-bed-fissure from which Professors Mercer and Cope had selected all that was worth having, contained some bone fragments in which the cellular structure of bone could be observed and also the gradual transition into the mealy condition or complete metamorphosis of bone phosphate into a mineral. I think a better proof could hardly be given of the gradual metamorphic change that has taken place in that locality. It seems to me that this fissure, which is V-shaped, had no outlet for the water which soaked the mixture of bones, ferruginous clay, twigs, fragments of sandstone, etc. and that the opportunity for mutual chemical dissociation was favorable to that effect. That carbon dioxide along with the water effected the change from the organic to the mineral in this case as in many others, scarcely requires demonstration. The phosphoric acid seemed to have been transposed and reunited with ferric oxide and with alumina to form vivianite and similar minerals, as indications of the presence of these species were noticed in the pile of débris near the bone deposit. In order to give some further proof of the almost complete change of the bone substance from the chemical standpoint, I endeavored to find the quantity of the carbonic acid gas volumetrically. I obtained by two measurements the average of 24.045 cubic centimeters at 0° C. temperature and 760 millimeters pressure of carbonic acid gas from 100 milligrammes of the mineral. This reduced to mass equals 47.23 per cent. It is evident that this rather high result must have a cause. Either there is another gas, or there is another oxide beside the lime. On determining the bases a large quantity of magnesia was found. The following is the result of the analysis:

CaO . . . . .	30.39 per cent.
MgO . . . . .	20.83 per cent.
CO <sub>2</sub> . . . . .	47.23 per cent.
Insoluble. . . . .	1.79 per cent.

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100.24

The insoluble part consisted mostly of sand, a trace of lime phosphate and oxide of iron. If these small quantities of phosphoric

acid, lime and oxide of iron would have been determined quantitatively, the general approximate result would not have differed much from the general result obtained. However, the differences appear when we recompute the oxides into salts such as they really are. We obtain about:

Calcium carbonate . . . . .	54.27 per cent.
Magnesium carbonate . . . . .	43.74 per cent.
Insoluble residue . . . . .	1.79 per cent.
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	99.80

From these numerical results it is plainly seen that the material is the mineral dolomite. Since bone phosphate contains generally but little magnesia, it may be assumed that this latter oxide must have been added when the transformation of the bone into the mineral took place.

Whether such a metamorphoses had ever been observed before is unknown to the writer at the present time. It was unknown to a number of chemists consulted, and, consequently, the conclusion was reached that all the possible metamorphic changes from the organic to the mineral kingdom may not have been observed.